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ABSTRACT

This report describes and discusses the uses of CAI in the teaching of handwriting, reading, and concept formation to children with learning difficulties. Following an introductory discussion of learning disabilities and teaching techniques, a computer-assisted approach to the instruction of handwriting which employs a digitiser light pen and a special display screen is outlined. A study investigating the effectiveness of the approach is summarized, and figures illustrate the development of one student's handwriting. The uses of computer synthesized speech and a special input panel for teaching basic reading skills such as word recognition are then presented. Applications of CAI to concept formation, specifically conservation of numbers and the development of spatial concepts, are also discussed, as well as experiments using an interactive color computer system to aid children in concept formation. A discussion of the problems involved in transferring into practice the results of educational technology research such as that described in this report and an overview of the implications of CAI as a means for increasing the effectiveness of educational programs for intellectually handicapped children conclude the report. A 13-item reference list accompanies the text. (JL)

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Computer-assisted instruction for the development of basic skills with intellectually handicapped school children.

Report to the Australian Education Research and Development Committee
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This report covers work carried out during the period 1980/81. The project was based in the Department of Engineering Physics at the ANU although much of the experimental work was done at The Woden School in Deakin, ACT.

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SUMMARY

This project has been concerned with the benefits of computer-assisted instruction for intellectually handicapped school children. Results indicate that this type of instruction is a useful adjunct to more conventional methods in the teaching of handwriting, reading and concept formation. The instructional programs developed during this project have utilised computer technology so that new and more powerful teaching techniques were devised. At no time was the aim to computerise existing techniques. In this way, computer-assisted instruction was used to add something new to pedagogics. This has required research endeavours in the field of man-machine communication. The VDU-keyboard configuration was discarded as a learning interface since successful operation of this interactive mode requires competence in certain basic skills. In its place, we have developed and used interactive terminals which are more appropriate to the learning characteristics and abilities of students. It is these interactive devices that have been responsible for our success in teaching basic skills to children who might otherwise be thought to be unteachable. As such, the efficacy of our programs has been well demonstrated.

This project has been carried out within a research environment. The transfer from research to practice is not a simple one but will require some considerable development. However, the potential usefulness of computer-assisted instruction is such that this development work would be insignificant in proportion to the derived educational benefit. In addition, it seems clear that the benefit of computer-assisted instruction will not be restricted to special education settings, but will be relevant to a much wider audience and to the educational problems inherent in Australia's geographical and cultural diversity.

INTRODUCTION

It is not uncommon to find children who do not seem able to gain competence in all or some of the basic skills of reading, handwriting and conceptual development. The reasons for this inability are many and varied: Some of these students are characterised by mild or moderate intellectual handicap, others by specific learning difficulties, while others are not so easily described.

Many of these students are placed in special education settings in order that they may improve their abilities in basic skills. However, this approach is limited by the fact that essentially the same teaching techniques are used in special as in regular education, albeit in smaller classes and with more individualised instruction.

The difficulty remains, however, where the child's inability to learn is related to the teaching procedure rather than to other factors. This can be seen in students who show little interest and skill in acquiring competence in such basic educational skills as handwriting and reading, while at the same time displaying great skill and interest in various video games, for example "Space-Invaders". There are many differences between the two activities although both have common features: Hand-eye coordination is necessary in both as is a requirement of the learner to direct his/her attention to the relevant aspects of the task, in addition to continually monitoring and reacting to various forms of task-oriented feedback.

Although there are many differences between video games and teaching basic skills using conventional classroom techniques, it is instructive to contrast the two. One aspect concerns the many psychological principles which underly successful video games and how they might be incorporated within conventional and computer-based skill development so that a learner's interest and motivation can be better utilized for teaching of basic skills.

Movement, sounds and colour are key elements in the interaction between player and video games. It is by these means that a player receives feedback about his/her performance at a specific time, in addition to information about the discrepancy between what is required and what has been achieved. Movement, sound and colour are used to assist the player in rapid decision making and to direct a player's attention to the critical aspects of the task and in a manner which is not disruptive to the task at hand.

It is instructive to note that these features are the same as those, described in the psychological/educational literature, for enhancing skill development and acquisition (Welford, 1976). It is little wonder then, that such video games become addictive and achieve a cult following. It is also not surprising that conventional teaching techniques do not "match up" to video games. However, the same technology which makes these games so popular is also available for computer-based teaching.

Described below are some examples of computer-based teaching which utilize technology to enhance the learning environment. Various principles of skill acquisition together with an appreciation for the learning characteristic of the student involved are combined with computer technology to develop a learning environment which stimulates and facilitates the development of handwriting, reading and concept formation.

HANDWRITING

Conventional methods for teaching handwriting involve variations on tracing and/or copying. However, in terms of well established psychological principles of skill acquisition these two methods could not be expected to be highly effective teaching procedures. In addition to those principles described earlier, skill acquisition requires a person to be accurate and to make active decisions during the time spent acquiring competence. However, these two factors are often incompatible since making decisions about a yet to be mastered skill implies a degree of error making. For example, tracing promotes accuracy but requires little thought (active decision making) about letter shapes, while the converse applies with copying.

A further necessity for skill acquisition is some means of transferring control of the behaviour from conscious to unconscious processes so that it becomes "automatic". As in any skill, a person is not conscious about the role of certain subprocesses; For example, it is not necessary for skilled handwriters to "think" about movements of the index finger of the writing hand, even though these movements are critical to the fluency of the skill. Apart from practice at the task, copying and tracing offer little assistance to the learner with respect to the transfer of control from slower conscious visual feedback processes to faster unconscious processes, which is necessary before the skill can be said to be automatic or fluent.

Our computer-based handwriting exercises incorporate these features so that a learner always has a degree of external support which is contingent upon his/her competence in the skill. These exercises impart a degree of control over the handwriting process that conventional techniques cannot do, while at the same time encouraging students to think about what they are doing with respect to what is expected of them in the skill. In addition, these exercises are designed to make the learner more aware of the role of higher-order control processes.

The equipment used for these exercises (See Figure 1) includes a display screen and an associated digitiser pen, which is the size and shape of a thick pencil. The computer calculates the pen position from the lengths of two fine strings attached to its tip and which pass through eyelets above the display. A switch inside the pen body indicates its up/down status and the impression of writing is given by drawing a lighted track under the pen tip as it is pressed down and moved around the display. Handwriting exercises are presented as a series of strokes, each of which has to be tracked before a guideline for the next is drawn. A cursor box drawn on the display indicates the calculated pen position.

Successful tracking requires the student to press the pen down at the beginning of each guideline and to move along it within an accuracy defined by the (variable) cursor box size. As students track successfully, the thin guideline changes into a thicker path. If the student starts at the wrong end of a stroke, lifts the pen or moves the cursor-box too far off the guideline, path filling stops and a small blinking spot calls attention to the point where the pen should be.

Students track various letters of the alphabet during training sessions. In some letters only portions of the outline are visible, although strokes for the complete letter are stored and the same criteria for successful tracking apply. Getting students to track incomplete stimuli encourages them to think about what is being traced and to predict the letter outlines from memory.

The effectiveness of this procedure was investigated by obtaining pencil on paper handwriting samples both before and after a training program. Rankings of the difference between these two samples by two teachers from different schools demonstrated a substantially greater improvement with the training group than with a comparison group which received conventional instruction (Lally, 1981a).

A further study investigated the effect of varying the cursor-box size with the computer-assisted handwriting exercises. This study indicated that use of a small cursor-box led to small improvements, a large size had no effect, and that a cursor-box size which was reduced from large to small, depending on the student's speed and accuracy of tracking, resulted in greatest improvement in handwriting. These results were consistent with the notion that what these exercises were doing was to use task-oriented feedback to shape the various motor responses involved in the handwriting process. Use of a large size allowed relatively inaccurate motor movements to be successful and the small size required quite fine movements from the very beginning of training. On the other hand, the reducing cursor-box size started with rather gross motor movements, resulting in successful tracking, but as the learner became more proficient at the task, the reduced size changed the task constraints so that finer and finer motor movements were required to track along the letter shapes. Further details of this study can be found in Lally (1982).

We have also investigated the effect of directing learners attention to the relationship between visual and muscular feedback processes. This relationship is important in the transfer of control to faster more unconscious processes. Beginning writers use visual feedback to guide pen movements, but this gradually gives way to muscular and to more internalised feedback processes. The role of muscular feedback in handwriting can be demonstrated by the difficulty in writing fluently with a numb index finger. This is discussed in Macleod and Lally (1981). At the same time, visual feedback is not irrelevant but assumes more of a checking mechanism, rather than as a direct control process.

By moving the cursor-box and the track from directly under the pen tip and displacing it by about 20 cm above the pen position, students could view their writing separately from hand and finger movements. As the pen produced no visible track under its tip, students needed to attend to nonvisual feedback from hand and arm movements in order to predict and control the writing produced on the display. This displaced pen-display configuration allowed magnification so that small pen movements resulted in larger visual movements on the display. This configuration aimed to facilitate more rapid transfer from the visual control used by beginner writers to the muscular control characteristic of fluent writers. In addition, the magnification resulted in appropriate muscular feedback being generated since although the visual letters produced were large enough for the learner to see what is happening, pen movements were of a size which

required small finger movements rather than whole hand and arm movements in order to successfully direct the cursor box.

Results indicated that this is an effective means of teaching handwriting skills (Lally, 1981b). The difference in what results were obtained using these different pen-display configurations is best exemplified by data presented in Figure 2. These data are from a 10 year old boy who is hydrocephalic with spastic haemoplegia. In addition, he has peripheral tunnel vision and mild intellectual handicap. IIa demonstrates his attempt at writing before any computer-assisted instruction. IIb shows his skill at writing his name, from memory and not copied, after 37 quarter-hour computer-assisted instruction sessions spread over 2 months. This writing, although large in size, is a dramatic improvement over his initial attempt. IIc is an example of this boy's writing after 25 quarter-hour sessions using the displaced pen-display configuration. It should be noted that the script being taught was changed from manuscript to cursive. The decrease in size is dramatic as is the general improvement of letter execution. His family name was also introduced at this stage and performance on this was equally impressive

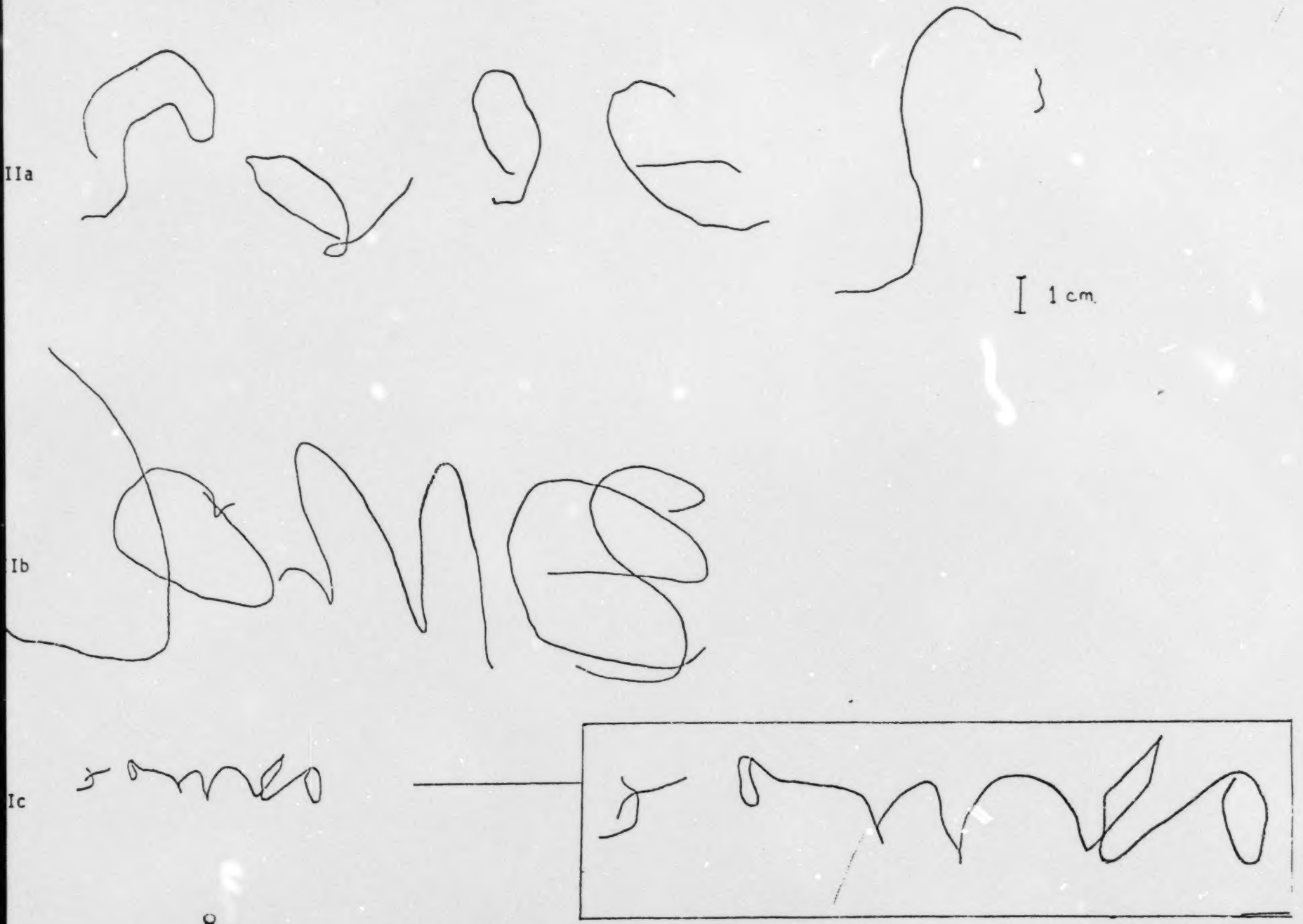

FIGURE 2

One of the difficulties in teaching beginning reading skills is to direct the learners' attention towards the relevant aspects of the problem so that irrelevancies in the task are identified and ignored.

An example is in teaching whole-word recognition using "flash-cards" To do this, a teacher shows the student a word written on a card while saying the word out loud. This is repeated many times so that the student learns to associate the visual and auditory forms of the word. This is at best a crude form of learning and is highly dependent on a child's motivation and attention. Furthermore it is difficult for a teacher to constantly repeat a word in a consistent manner without changes in accent, intonation and so on. These inconsistencies, while small and irrelevant from the point of view of a successful reader, can create difficulties for a person who is learning to discriminate between what is relevant and what is not.

One of the advantages of using computer synthesised speech as the medium for communicating information and instruction to preliterate students is its consistency. A word can be presented in exactly the same way and as many times as is necessary. Another advantage of using a computer-based technique is the capacity for continual monitoring of performance so that programs can be made more individual. In this way, large error rates can be avoided with the result that a child's self concept and motivation can be maintained throughout an extended learning exercise.

We have evaluated a sight recognition program in which students were taught a beginners' reading vocabulary of 105 words. During exercise sessions, overlays of sixteen words were placed over a matrix of sixteen large buttons. Twelve different overlays were used to present the training words. Each overlay had versions with the same words in different positions to avoid responses based on sound-position associations.

The computer gave instructions such as "Press was". If the student responded correctly, then a light under the appropriate word flashed and the computer said the word three times. If the student pressed the wrong word, say saw instead of was, then the computer responded with "You got saw, try again, press was". If the student had not responded after five seconds, or had already made more than one error, the light under the correct word began to flash. When the student pressed this word, after prompting, the machine said "Right, but try again, Press was". The same word was presented until the student responded correctly within the given time interval. Presentation of new words occurred only after correct responses In this way, the learner was not swamped with a large number of different and unknown words, but rather dealt with a small subset of word until these were correctly recognised causing the subset to gradually increase, until it reached sixteen. At the end of each set of sixteen trials, the computer gave verbal results to the student.

Students in the training group received five hours of computer-assisted instruction over a period of four weeks. During this period the average number of words recognised increased from 38.5 to 68.6 compared with 37.5 to 42.6 for a comparison group. Furthermore, a half year later and with no

further computer-assisted instruction, the training group recognised an average of 70.9 words while the comparison group recognised 47.2. Further details about this study can be found in Lally (1981c).

A doctoral student involved with the project has extended our work in the area of reading. She has investigated a computer-based program which helps focus a student's attention on semantic and grammatical cues using a modified cloze procedure. Aspects of this work are described in Grocke (1981).

Our subsequent research has used equipment which made interaction between learner and reading material even more flexible than that described above. This work utilised a touch sensitive screen so that students need only press down on an appropriate area of the display for a response to be recorded. The added flexibility of a display screen, rather than word overlays on top of buttons, meant that students could easily investigate sentence building.

In this procedure, students see on the display a menu of word types: "a" which signifies words beginning with the letter a, "verb" meaning a variety of verbs, an so on. Once a student has selected the word type, by pressing on the appropriate section of the display, the word type menu is erased and a selection of those words (for example, words beginning with the letter "a"), appears on the display. When a particular word is then pressed, it is written on the display screen just above the word menu. The first letter of the first word in the sentence is automatically converted to upper-case and the student signals the end of a sentence by pressing an area of the screen which places a "." at the end of the sentence displayed on the screen. When the sentence has been completed, it is spoken by the speech synthesiser and written out by a printer. At the end of a session the student has a record of his/her sentences to take home.

We have been surprised by the interest and creativity that students have demonstrated in this activity. Indeed, this procedure has often been used as a reward for the word recognition exercise described earlier.

CONCEPT FORMATION

Piaget has discussed in great detail the ways in which children develop concepts of space, number and time (Piaget, 1928). He suggested that cognitive development comes about by the child interacting with the world so that cognitive contradictions occur. His theory maintains that a child is forced to elaborate his/her model of the world when an exception to the current state of the model occurs. These exceptions occur as the child interacts (applies his/her model) with the cognitive environment.

One way of promoting cognitive development is to enhance the learner's environment so that the child's model of the world is somewhat, but not totally, inadequate. This inadequacy of the model results in the child identifying and hypothesising about the shortcomings of his/her present view of the world. It is in this way that a child's concept of the world gradually increases in complexity and becomes a better working model.

It is important to note that a too advanced environment will cause the child's model of the world to be completely inadequate with the result that the child has no frame of reference to work from. It is therefore necessary

to construct a learning environment which is demanding to the child but at the same time being within the competence of the child's level of functioning.

We have investigated two applications of computer-based learning environments for concept formation: Conservation of number and basic spatial concepts. These training programs indicated to students contradictions in their cognitive judgments. Whereas a verbal rule would be specific to a certain situation, experience of contradiction should result in changes to the underlying cognitive structures and thus result in more global cognitive development.

Conservation of number is a prerequisite for other number skills. With respect to judgments of numerical equivalence, Piaget has outlined three stages of development. A nonconserving child in stage one determines equality of lengths solely by equality of lengths, whereas during stage two the child uses the dimensions of length and density at different times. The stage two child recognises the relevance of both dimensions but is unable to cognitively overcome the strong perceptual factors inherent in the task. The conserving child at stage three has recognised the reciprocal relationship between density and length and is able to decentre his/her attention from the salient perceptual factors.

In our training program, the student faced a colour monitor with a matrix of buttons in front. Two rows of squares were then displayed on the screen, each row having a different colour and different orientation. On half the trials there were equal numbers of coloured squares whereas on the other, one row had one more square. The different coloured squares were of equal size on individual trials although together with the colours and orientations of the squares, they varied from trial to trial. The computer then asked the child if both colours had an equal number of squares. The child could respond by pressing the button with the "=" sign, or a coloured button if he thought that colour to have more squares. The computer responded to this with "You said (equal/more red). Let us count them" Button number one then lit up. When the child pressed this button the computer said "One red" and moved one of the red squares across to the bottom right hand corner of the screen, then said "One blue" and moved one of the other squares, in this case blue, to a position alongside the red square in the bottom right hand corner. The number two button then lit up and after it was pressed the computer counted and moved the second squares.

In this manner, the child and computer stacked the squares in two piles so that the numbers of squares became obvious. If the child made a correct response, the computer replied with "That was right, there were more red squares", and then told the child how to start the next trial. If an incorrect response was made (say equal instead of more red) the computer said "You said equal but look at the screen, there were more red squares". Instructions were then given on how to proceed to the next trial. On the next trial at least one of the colours was different, the orientation and size was different, and the answer might or might not be the same.

Students needed very little training in order for them to interact with the task Comments from children doing this task indicated that they enjoyed the interaction and that they viewed the task as one in which they were in control of the interaction. Their perception of the interaction was

such that they believed themselves to be manipulating the buttons and coloured squares. It was also interesting to see how powerful the instruction to "look at the screen" was, since it was very effective in directing the student's attention away from the button array towards the stacked up squares. This training procedure was successful in developing some of the children's concept of number although their strategies seemed to be limited to the linguistic environment that was used in the training program. A more complete description of this program is given in Lally, 1980.

The success of this student-computer interaction encouraged us to devise a similar one for development of spatial concepts. The cognitive ability of the population with whom we were working was such that we were able to investigate basic concepts like left/right, inside/outside, above/below, corner/side etc.

During training sessions children sat in front of an array of 8 X 8 white buttons which could be individually lit or extinguished. Various patterns could be formed on this matrix by differentially lighting buttons. As students pressed different buttons, the computer described the spatial relationship between that particular button and the reference pattern; eg., "bottom left corner of the square". Children were free to change the reference pattern at any time and were told that they could press any one of the 64 buttons, and in any sequence they wished.

This program was successful in developing concepts of left/right, above/below, and to a lesser extent inside/outside (as measured on the Boehm Test, Boehm, 1971). However, an examination of the frequency with which different buttons were pressed by students revealed an interesting and unexpected pattern. Although children seemed to enjoy the procedure, their explorations of the button patterns were quite limited. Many buttons which were near pattern contours and were relatively informative, eg., bottom-left-corner were never or rarely pressed while other buttons which were lower in information content, eg., below were pressed frequently. Our suspicion that this strategy was unusual was confirmed by looking at how younger nonretarded children, presumably at a similar cognitive level, investigated the same environment. Their exploration was more varied and tended to concentrate near contours of patterns; ie., near points of higher information content.

This finding is consistent with our other work in suggesting that the problem of directing learners' attention to the relevant, and therefore informative, aspects of a learning environment is of critical importance in teaching basic skills.

DISCUSSION

At the beginning of this report we described differences between video games and more conventional educational media yet our work in computer-based teaching indicates that there are many parallels between them. The most striking similarity between the two is in the use of technology to direct a learner's attention to the relevant aspects of learning environments. This facility means that technology can be used to implement an instruction paradigm that would not be possible with conventional teaching aids. Thus, the technology is not being used to simply computerise existing procedures but rather, is employed to extend the range of possible teaching paradigms

available to students. It is increased control over critical learning processes that becomes possible with computer-based techniques so that development of new and better teaching procedures is possible.

The psychological/educational literature abounds with reports which implicate the importance to learning of such processes as task-oriented feedback, directed attention, active-decision making, self-generated motivation discovery learning, etc. (Gagne, 1970; Welford, 1976). Unfortunately, with conventional classroom teaching methods, the relevance of these research findings has been limited by differences between laboratory and field constraints; With respect to the degree of control over the various learning processes in the two. On the other hand, we have demonstrated that computer-based techniques can incorporate these experimental findings.

Thus, it is the technology itself which makes the learning environment such a powerful one. Video games have developed in much the same way: They utilise features which make the interaction both interesting and challenging. Computer-based teaching has the potential to do the same so that learning basic skills can be seen from the student's point of view as more interesting and akin to a game, rather than as an uninteresting and irrelevant task.

The question which must now be addressed is how to make the transfer from research to practice. It is one thing to demonstrate such results and techniques on equipment which is expensive, highly flexible and research oriented. It is another matter altogether to transfer the benefits of this research to individual classrooms out in the schools. With the termination of ERDC, this transfer from research to practice will be difficult since, although much of the research has been completed, the transfer to practice is not a simple matter. However, there are several possibilities which might be explored with regard to how these results might be implemented in the classroom.

One way would be to exploit developments in telecommunications so that the type of learning environment developed here could be made available to students throughout Australia, including those isolated by geographical factors. Telecommunications, including the proposed satellite, could be used to link interactive student units situated in classrooms to resource centres. These units would, however, be independent so that teachers could use them for their own purposes. The link would provide resource material when needed and would allow students to receive specialised instruction in their own classroom rather than having to travel to an educational clinic or wait until a resource teacher arrives at the school. Thus, students could have access, within their peer group, to a wider range of educational material while at the same time giving to the teacher a means by which he/she can be informed as to what instruction an individual child is receiving. A more complete description of such a network is given in Lally and Macleod (1982). This description is a development of a proposal originally put forward to a working party of the Director Generals of Education: The Working Party into Educational Uses of Telecommunications (Commonwealth Education Department, 1980).

Another way of disseminating our procedures would be to duplicate our programs on microcomputers, of the type becoming more widely available individual schools. A difficulty in this approach is the difference in power and flexibility between microcomputers and the larger machines used for research. Another difficulty comes from the means of student-machine interaction. We have avoided the keyboard-VDU as the interface whereas most microcomputer systems use this as the standard means of interaction. However, we are currently (with funding from the Schools Commission) transferring our program to teach sight-word recognition to operate on a 48K Apple microcomputer. This application is using a low resolution light-pen to collect responses and a "Supertalker" to deliver audio. Both peripherals are available commercially with an add-on cost of under $500.

A third alternative which may be possible in the future would be a combination of the above two. An advantage of using microcomputers for the transfer of research to practice is that many schools have access to these machines and that most school systems have standardised on the same machine. However, it has the disadvantage of many schools working in isolation with inefficient and costly duplication of ideas occurring. What is needed is some means by which these microcomputers can link into a common telecommunications system. In this way, a network could be achieved so that resource material could be inexpensively sent to schools throughout Australia, and any child having difficulty in a certain curriculum area could have rapid access to specialist material. Such a network could be achieved if a standard videotext system were adopted throughout Australia since for example, the Canadian developed Telidon system has an interface for the Apple microcomputer.

CONCLUSIONS

This project has been concerned with the benefits of computer-assisted instruction for intellectually handicapped children. As such, results indicate that this instruction has much to offer these students in the areas of handwriting, reading and concept development. The importance of our techniques is increased by the fact that competence in these basic skills is a prerequisite both for further learning and for survival in the social environment. If intellectually handicapped children are to eventually lead a life with any sort of freedom and independence, then competence in basic skills is the minimal level of ability required. It is in this very area that our techniques have been demonstrated to be highly effective.

Another implication of this project is that the effectiveness of computer-assisted instruction is related to the structure of the programs. That is, it is not the computer per-se which is responsible for improvements in learning, but rather, it is the way in which the computer is used. This is best exemplified by our study of the role of the cursor-box size in the handwriting procedure. Results of this study indicated that a cursor-box size which was reduced in accordance with student performance was most successful in improving handwriting. Of interest was the finding that students who used only the large cursor-box showed no improvement at all over the training period. It is important to note that students in this study were quite familiar with the computer and had used it over a relatively long period of time.

The importance of this finding is related to the common practice of evaluating computer-assisted instruction programs over a short period of time. A child who is fascinated with the machine may well show improvements over a time period of several days but may lose interest and learning with the same program over a period of weeks. Thus, it is important to know that the program is effective over a long period of time.

A large number of educators have visited our project and the common reaction has been one of surprise that what we have been doing with computer-assisted instruction does not imply the demise of classroom teachers. There is a belief that computers have the potential to replace teachers; This belief and fear has been brought about by the fact that the majority of computer-assisted instruction programs used today do little more than duplicate what a teacher does. Thus, teachers see the computer doing exactly what they do with the result that they view these machines as possible rivals in their profession.

Our approach has been different. We have not sought to computerise existing techniques but rather, we have exploited the power of the technology by using the computer to develop new and more effective teaching procedures. In this way, techniques developed are seen as adjuncts to a teacher's existing repertoire. Thus, computer-assisted instruction becomes another tool which the teacher can use, when and for whom the teacher determines that it is appropriate.

It is important to stress that for this type of computer-assisted instruction, a flexible means of interaction between student and machine is needed. Computer-assisted instruction will not reach its potential in the area of basic skill development until the VDU and keyboard are replaced as the interface between learner and machine. Our data indicate that there are large and significant student gains if the interaction between student and computer is made more appropriate to the ability level of the learner.

This project has demonstrated the efficacy, with intellectually handicapped school children, of computer-assisted instruction programs that we have developed. However, our results indicate that the benefits of such interaction are relevant to a much wider audience. It is reasonable to expect that the widespread use of such instruction in teaching handwriting, reading and concept formation would lead to a higher overall standard and a reduced time for students to achieve competence in these basic skills. Such a reduction in time would have wide ramifications in school curricula since reading, writing and concept development are the building blocks for later education.

REFERENCES

Boehm, A. E. (1971) Boehm test of basic concepts manual. NY: The Psychological Corporation.

Commonwealth Education Department (1980) Report of Conference of Director-Generals of Education Working Party on the Educational Use of a Communications Satellite. Commonwealth Government Printer, Canberra.

Gagne, R. M. (1970) The conditions of learning (2nd Ed.). New York: Holt, Rinehart and Winston.

Grocke, M. (1981) Computer-assisted reading instruction for intellectually handicapped children. In W.H. Gladstones (Ed.) Ergonomics and the Disabled person Australian Government Printers, Canberra.

Lally, M. (1980) Computer assisted development of number conservation in mentally retarded school children. Australian Journal of Developmental Disabilities 6, 131-136.

Lally, M. (1981a) Computer-assisted handwriting instruction for retarded school children. Submitted for review.

Lally, M. (1981b) Computer-assisted handwriting instruction for intellectually handicapped children and the role of visual and kinaesthetic feedback processes in W.H. Gladstones (Ed.) Ergonomics and the Disabled person Australian Government Printers, Canberra.

Lally, M. (1981c) Computer assisted teaching of sight word recognition to retarded school children. American Journal of Mental Deficiency 85,383-388.

Lally, M. (1982) Computer-assisted handwriting instruction and visual/kinaesthetic feedback processes Applied Research in Mental Retardation (in press).

Lally, M. and Macleod, I. (1982) Computer-based management and delivery of special education services. In Proceedings of the 9th Australian Computer Conference. Hobart, Tasmania.

Macleod, I and Lally, M. (1981) The effectiveness of computer controlled feedback in handwriting instruction. In R. Lewis and E.D.Tagg (Eds.) Computers in Education North Holland, Amsterdam.

Piaget, J. (1928) Judgment and reasoning in the child. London: Routledge and Kegan Paul.

Welford, A. T. (1976) Skilled performance: Perceptual and motor skills. Glenview,IL.: Scott, Foresman and Co.

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